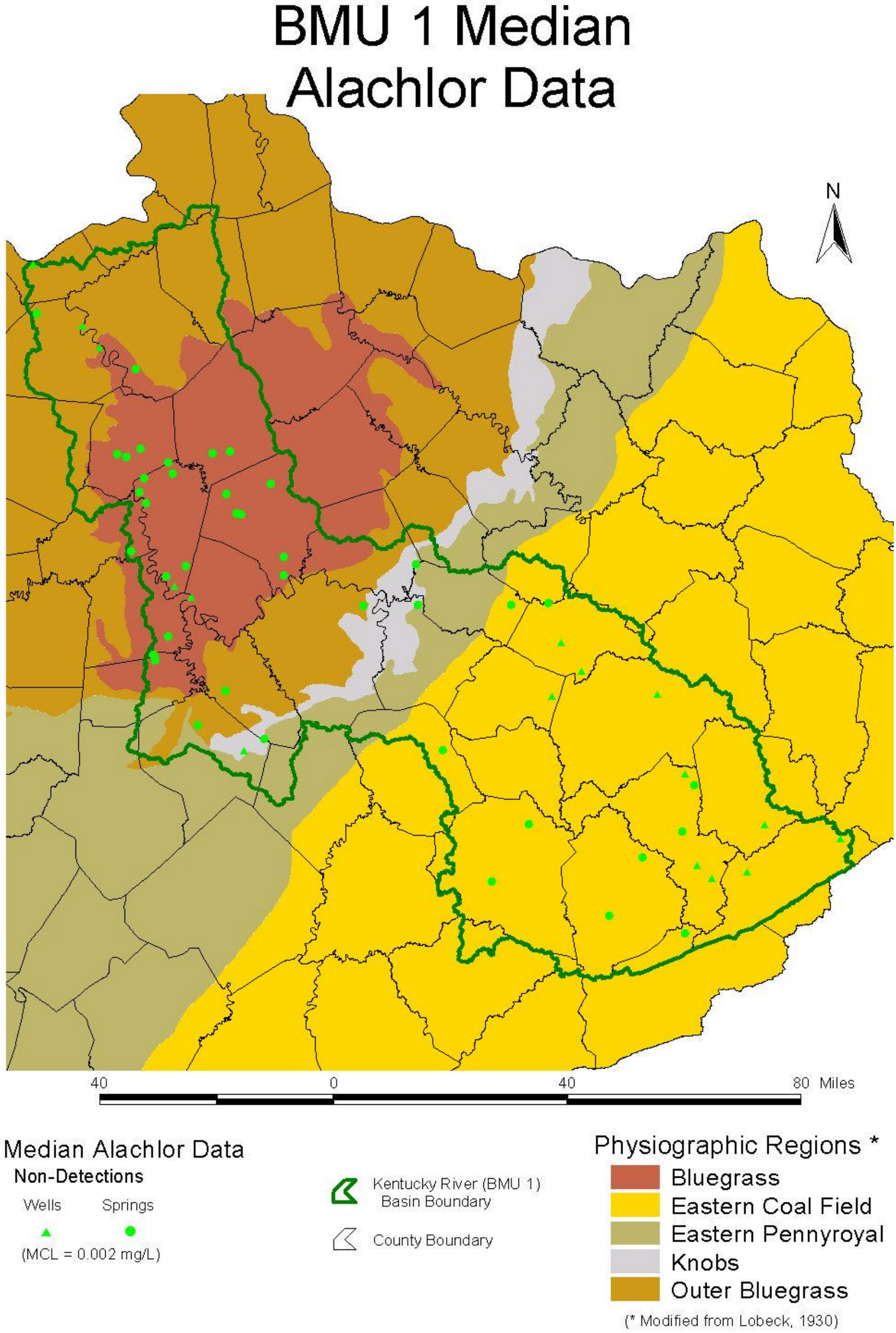

Figure 39. Alachlor Map

Alachlor was detected in only two of 563 samples, or 0.4% (Table 12). These detections occurred in the Bluegrass (Figure 39), but did not exceed MCL. Alachlor is a nonpoint source pollutant, although minor, in BMU 1, but monitoring for this compound should continue.

Cyanazine production ceased in December 1999 and the sale and use of this herbicide was prohibited effective September 2002. Cyanazine was analyzed for in 522 samples, but not detected (Table 13). These results indicate that, at least in BMU 1, cyanazine is not a nonpoint source pollutant of concern.

Residues (Total Dissolved Solids (TDS) and Total Suspended Solids (TSS))

Descriptive statistics and summaries for the residues included in this report are shown in Tables 15 and 16.

Total Dissolved Solids (TDS) measures the solids remaining in a water sample filtered through a 1.2 μm filter. According to the World Health Organization (WHO, 1996), the compounds and elements remaining after filtration are commonly calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chloride, sulfate, silica and nitrate-N. High TDS affects the taste and odor of water and in general, levels above 300 mg/L become noticeable to consumers. As TDS increases, the water becomes increasingly unacceptable. Although the SMCL for TDS is 500 mg/L, levels above 1200 mg/L are unacceptable to most consumers. Because TDS measurements may include a variety of parameters, which can be naturally occurring, or anthropogenic, its value as an indicator of nonpoint source pollution is limited.

In this study, TDS was analyzed for 558 samples (Table 15), and found in 546, or 97.8%. A maximum value of 3200 mg/L was found in the Eastern Coal Field, where the median was 501 mg/L, which slightly exceeds the SMCL (Table 16). TDS was most variable in the Eastern Coal Field and forested areas (Figures 40 and 41). The SMCL was exceeded at 21 sites (Figure 42): ten each in the Bluegrass and Eastern Coal Field and at one site in the Ohio River Alluvium.

Table 15. Residues Summary

BMU1: RESIDUES SUMMARY		TDS[2]	TSS[1 3]
NUMBER OF SAMPLES	TOTAL:	558	560
BY REGION:	BLUEGRASS (INNER & OUTER):	347	347
	EASTERN COAL FIELD:	134	135
	MISSISSIPPIAN PLATEAU:	73	74
	OHIO RIVER ALLUVIUM:	4	4
NUMBER OF DETECTIONS	TOTAL:	546	333
	% DETECTS (vs SAMPLES):	97.8%	59.5%
BY REGION:	BLUEGRASS (INNER & OUTER):	345	221
	EASTERN COAL FIELD:	129	81
	MISSISSIPPIAN PLATEAU:	68	29
	OHIO RIVER ALLUVIUM:	4	2
NUMBER OF DETECTIONS ABOVE STANDARD	TOTAL:	86	19
	% DETECTIONS > STANDARD (of SAMPLES w/DETECTIONS):	15.8%	5.7%
	% SAMPLES > STANDARD (of TOTAL SAMPLES):	15.4%	3.4%
BY REGION:	BLUEGRASS (INNER & OUTER):	17	16
	EASTERN COAL FIELD:	67	2
	MISSISSIPPIAN PLATEAU:	0	1
	OHIO RIVER ALLUVIUM:	2	0
NUMBER OF SITES[3]	TOTAL:	57	57
BY REGION:	BLUEGRASS (INNER & OUTER):	33	33
	EASTERN COAL FIELD:	19	19
	MISSISSIPPIAN PLATEAU:	4	4
	OHIO RIVER ALLUVIUM:	1	1
NUMBER OF SITES WITH DETECTIONS	TOTAL:	57	52
	% SITES W/DETECTIONS:	100.0%	91.2%
BY REGION:	BLUEGRASS (INNER & OUTER):	33	29
	EASTERN COAL FIELD:	19	18
	MISSISSIPPIAN PLATEAU:	4	4
	OHIO RIVER ALLUVIUM:	1	1
NUMBER OF SITES WITH DETECTIONS ABOVE STANDARD	TOTAL:	21	13
	%SITES w/DETECTIONS>STANDARD (of SITES w/DETECTIONS):	36.8%	25.0%
	%SITES w/DETECTIONS>STANDARD (of TOTAL SITES):	36.8%	22.8%
BY REGION:	BLUEGRASS (INNER & OUTER):	10	10
	EASTERN COAL FIELD:	10	2
	MISSISSIPPIAN PLATEAU:	0	1
	OHIO RIVER ALLUVIUM:	1	0
	MCL (mg/L)	Secondary (mg/L)	Other
TDS	-	500	-
TSS	-	-	35

[1] Currently no water quality standard for TSS; some KPDES permits use 35 mg/L monthly avg

[2] Only 558 TDS values out of 565 samples:
3 analyses: lab analyses for only pesticides and PCBs,
1 analysis: lab analysis for metals only,
1 analysis: no analysis for TDS,
1 analysis: could not be performed for TDS or TSS since no bulk split received for sample,
1 value could not be verified (Wm Whitley well - 60,364 mg/L) - treated as missing value.

[3] Only 560 TSS values out of 565 samples:
3 analyses: lab analyses for only pesticides and PCBs,
1 analysis: lab analysis for metals only,
1 analysis: could not be performed for TDS or TSS since no bulk split received for sample.

Table 16. Residues Descriptive Statistics

BMU1: RESIDUES DESCRIPTIVE STATISTICS						
	TDS (Total Dissolved Solids) (mg/L)					
	START DATE	END DATE	MAX	MEDIAN	MIN	MODE
TOTAL:	**04/26/95**	**06/11/03**	**3200**	**326**	**< 1**	**< 10**
BLUEGRASS (INNER & OUTER):	04/26/95	06/11/03	908	322	< 1	284
EASTERN COAL FIELD:	05/02/95	05/28/03	3200	501	6.34	< 10
MISSISSIPPIAN PLATEAU:	05/03/95	06/11/03	462	266	< 10	< 10
OHIO RIVER ALLUVIUM:	04/21/99	03/07/00	563	494	484	484
	TSS (Total Suspended Solids) (mg/L)					
	START DATE	END DATE	MAX	MEDIAN	MIN	MODE
TOTAL:	**04/26/95**	**06/11/03**	**1520**	**< 3**	**< 1**	**< 3**
BLUEGRASS (INNER & OUTER):	04/26/95	06/11/03	1520	< 3	< 1	< 3
EASTERN COAL FIELD:	05/02/95	05/28/03	40	< 3	< 1	< 3
MISSISSIPPIAN PLATEAU:	04/27/95	06/11/03	73	< 3	< 1	< 3
OHIO RIVER ALLUVIUM:	04/21/99	03/07/00	1	< 1	< 1	-

As noted above, the value of TDS as an indicator of nonpoint source pollution is limited, and the values in this study are apparently the result of naturally occurring rock/water chemistry.

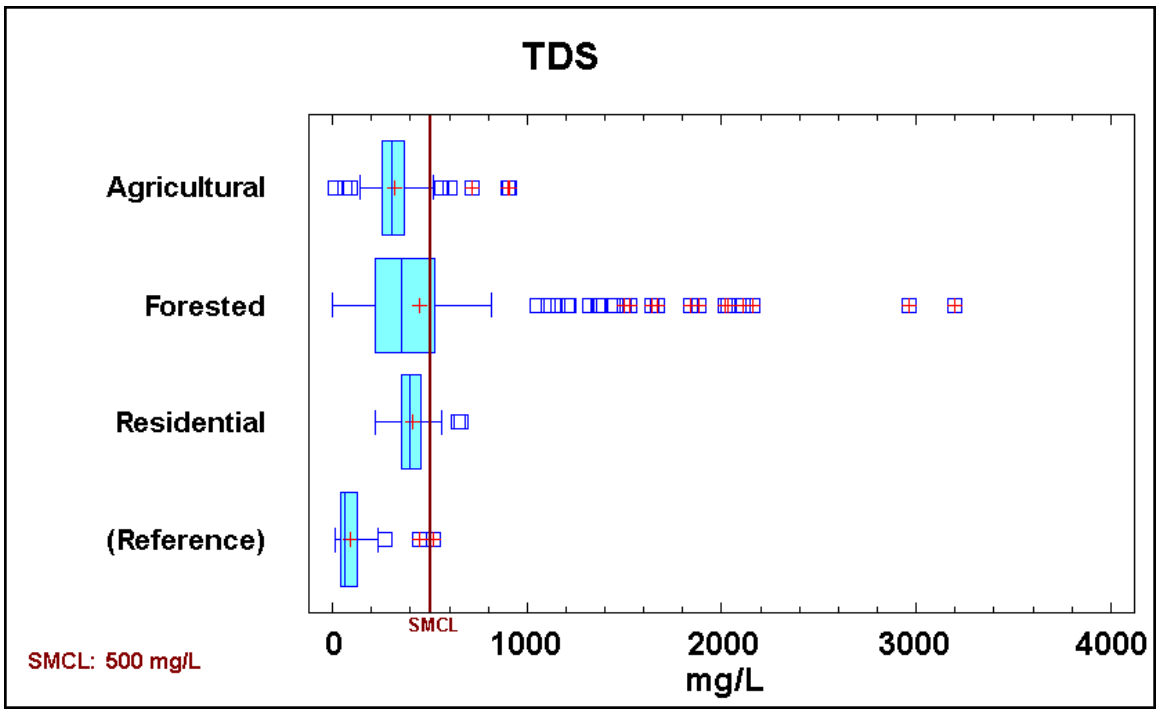

Figure 40. Boxplot of TDS and Land Use

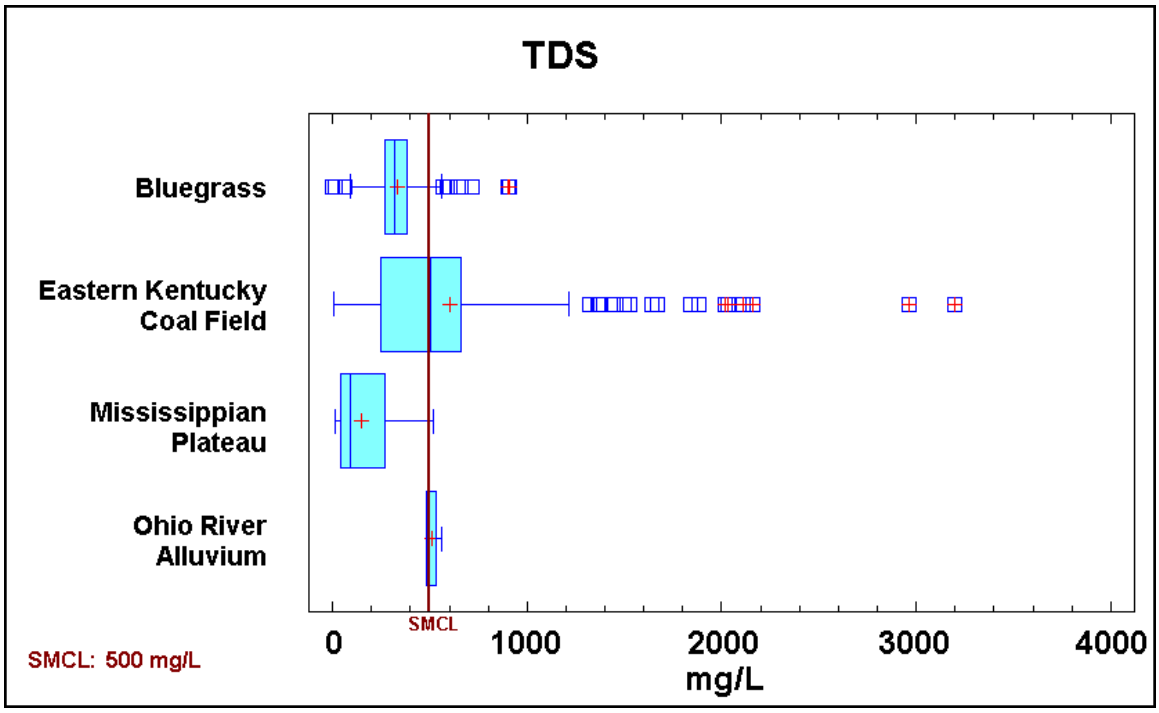

Figure 41. Boxplot of TDS and Physiographic Regions

Total Suspended Solids (TSS), also known as non-filterable residue, are those solids (minerals and organic material) that remain trapped on a 1.2 µm filter (US EPA, 1998). Suspended solids can enter groundwater through runoff from industrial, urban or agricultural areas. Elevated TSS (MMSD, 2002) can ". . . reduce water clarity, degrade habitats, clog fish gills, decrease photosynthetic activity and cause an increase in water temperatures." TSS has no drinking water standard. Therefore, data in this report are compared to the KPDES surface water discharge permit requirement for sewage treatment plants of 35 mg/L.

TSS was measured in 560 samples and detected in 333, or 59.5%, and the KPDES standard was exceeded in 19 samples (Tables 15 and 16). Median values for TSS in BMU 1 are low, as shown in Figures 43 and 44, but outliers occur. Map distribution of TSS in BMU 1 is shown in Figure 45. TSS is generally not considered an indicator of nonpoint source pollution. In summary, TSS occurrence in this study is most likely naturally occurring and not from nonpoint sources.

BMU 1 Median Total Dissolved Solids (TDS) Data

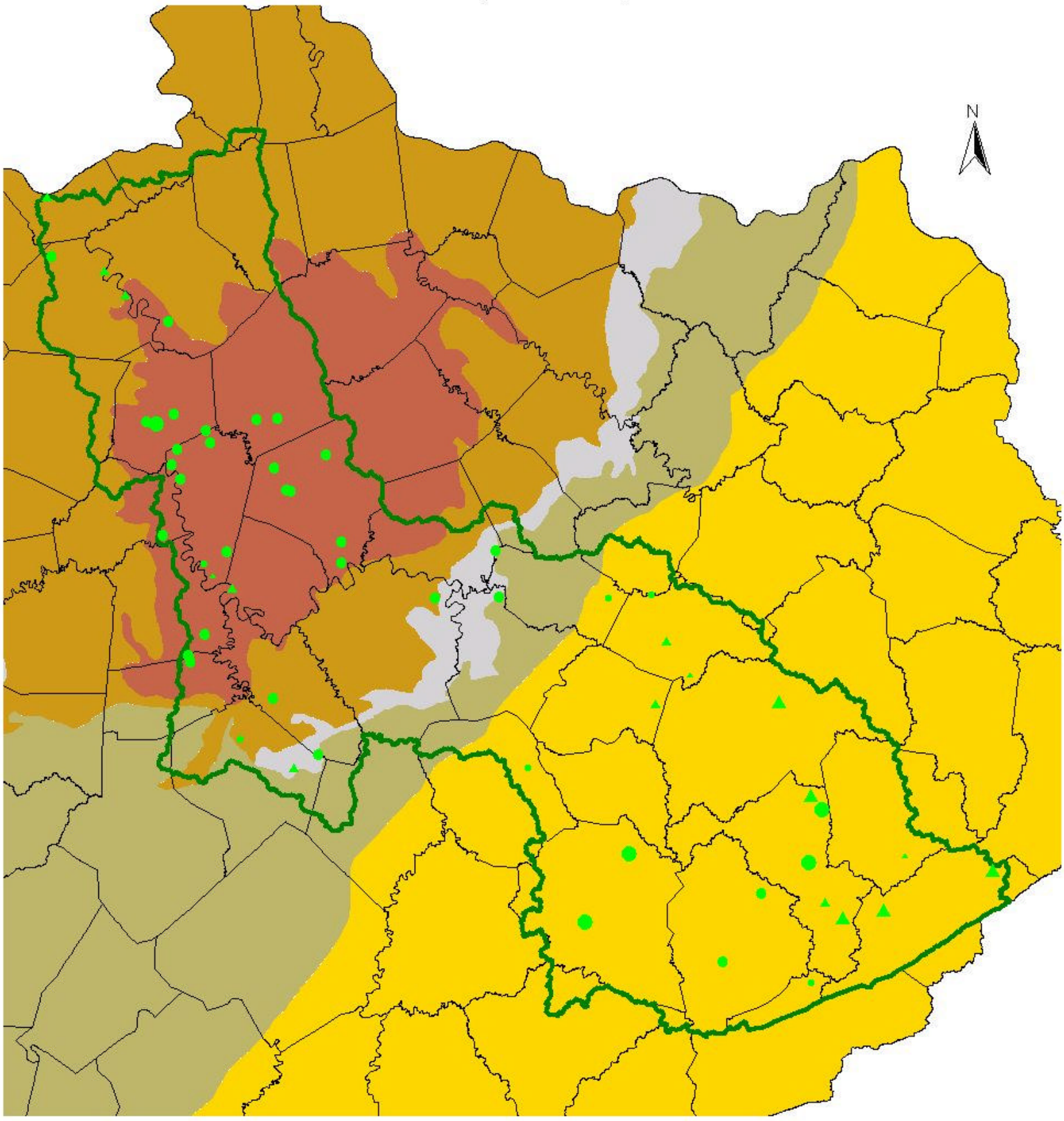

Figure 42. TDS Map

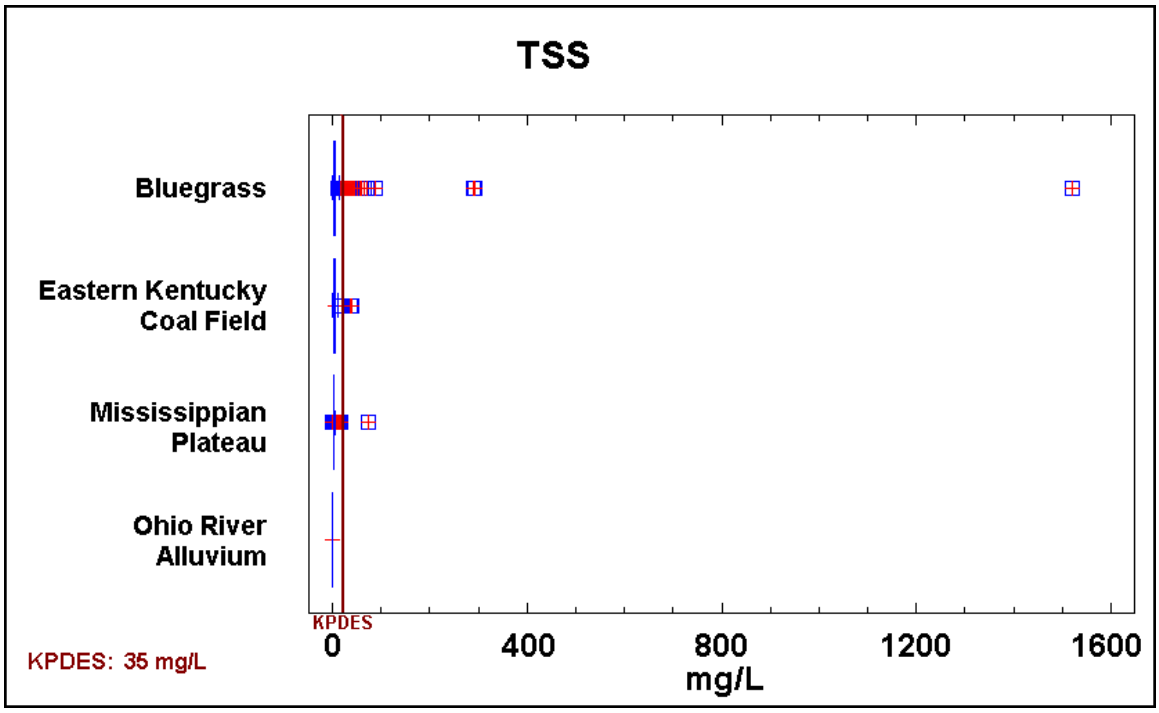

Figure 43. Boxplot of TSS and Physiographic Regions

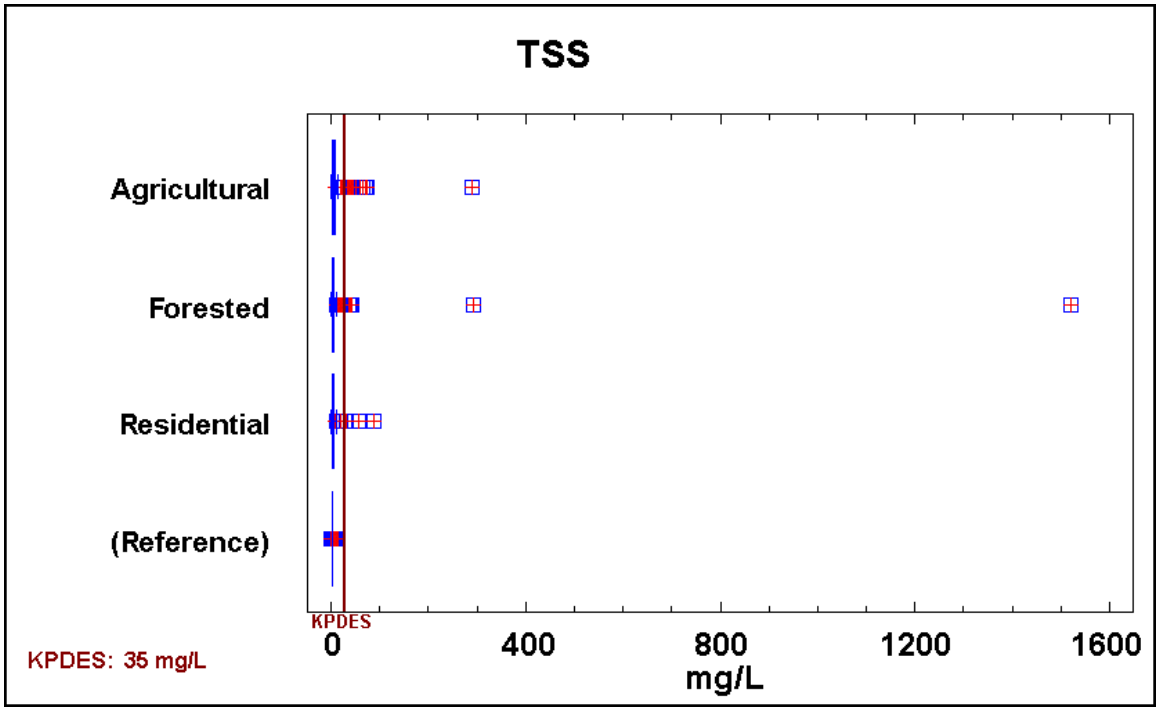

Figure 44. Boxplot of TSS and Land Use

BMU 1 Median Total Suspended Solids (TSS) Data

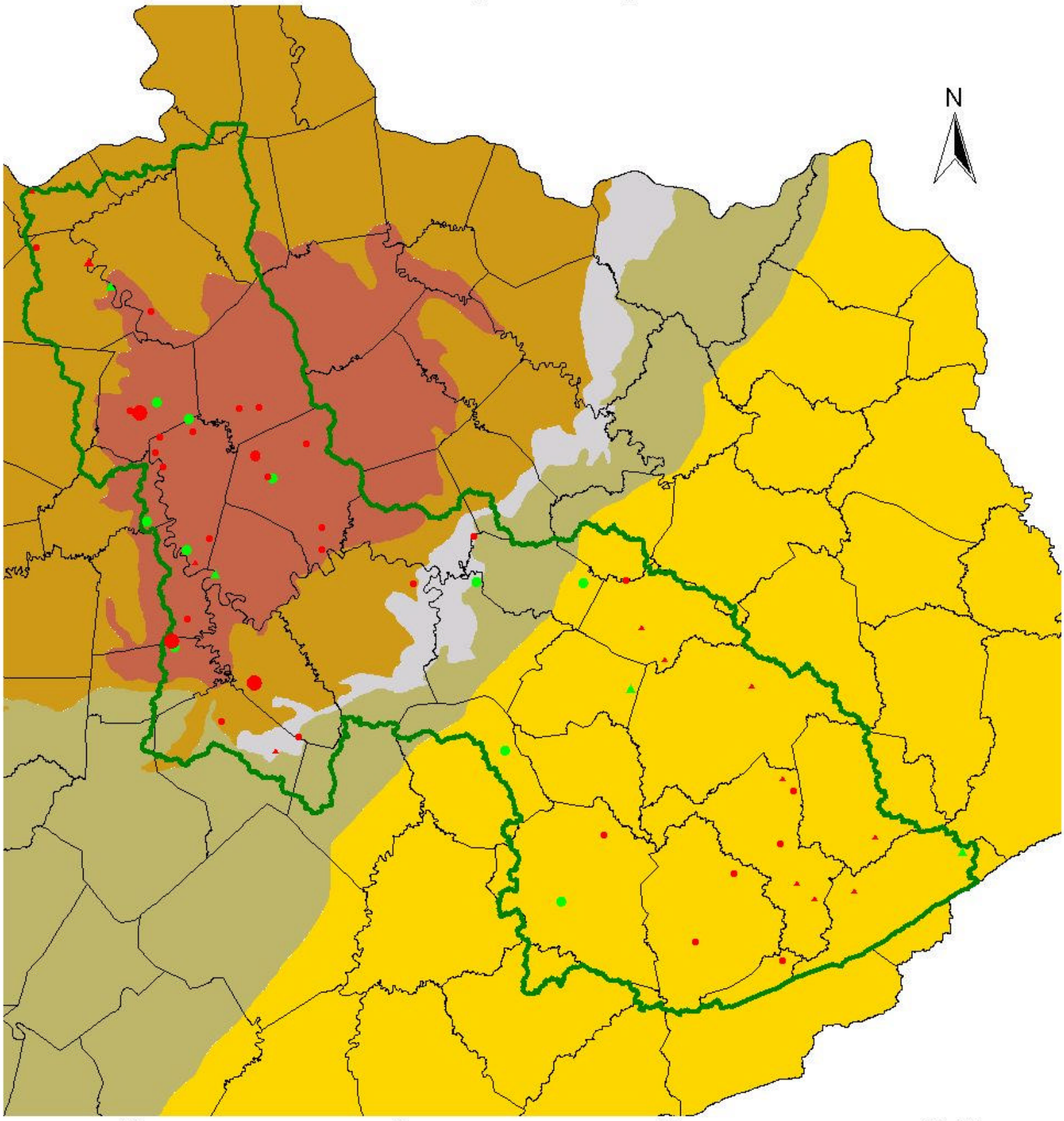

Figure 45. TSS Map

Nutrients (Nitrate-N, Nitrite-N, Ammonia-N, Orthophosphate-P, Total Phosphorus)

Nutrients included in this report are nitrate-N, nitrite-N, ammonia-N, orthophosphate-P and total phosphorous. Summaries and descriptive statistics are shown in Tables 17 and 18.

Nutrients are particularly important in surface water, where they are the main contributors to eutrophication, which is excessive nutrient enrichment of water. This enrichment can cause an overabundance of some plant life, such as algal blooms and may also have adverse effects on animal life, because excessive oxygen consumption by plants leaves little available for animal use. In addition to comparisons with various water quality standards, nutrient data from sites in this study were compared to the two reference springs.

Nitrate-N (NO_3) occurs in the environment from a variety of anthropogenic and natural sources: nitrogen-fixing plants such as alfalfa and other legumes, nitrogen fertilizers, decomposing organic debris, atmospheric deposition from combustion and human and animal waste. Nitrate-N is reported either as the complex ion NO_3, or as the equivalent molecular nitrogen-n. Since 1 mg/L of nitrogen equals 4.5 mg/L nitrate-N, the drinking water MCL of 10 mg/L nitrate-N equals 45 mg/L nitrate-N. In this report, results are reported as "nitrate-N."

In infants, excess nitrate-N consumption can cause methemoglobinemia or "blue-baby" syndrome. In adults, possible adverse health effects of nitrate-N ingestion are under study and much debated. Because nitrate-N is difficult to remove through ordinary water treatment, its occurrence at levels above the MCL in public water systems is an emerging problem, as well as a public health concern.

Table 17. Nutrients Summary

BMU1: NUTRIENTS SUMMARY		AMMONIA[3] (NH_3-N)	NITRATE[4] (NO_3-N)	NITRITE[5] (NO_2-N)	ORTHO-PHOSPHATE[1 6] (PO_4-P)	TOTAL PHOSPHORUS[2 7]
NUMBER OF SAMPLES	TOTAL:	560	559	546	549	426
BY REGION:	BLUEGRASS (INNER & OUTER):	347	348	336	338	270
	EASTERN COAL FIELD:	135	133	132	133	108
	MISSISSIPPIAN PLATEAU:	74	74	74	74	44
	OHIO RIVER ALLUVIUM:	4	4	4	4	4
NUMBER OF DETECTIONS	TOTAL:	107	512	304	417	325
	% DETECTS (vs SAMPLES):	19.1%	91.6%	55.7%	76.0%	76.3%
BY REGION:	BLUEGRASS (INNER & OUTER):	65	325	211	304	255
	EASTERN COAL FIELD:	34	114	46	57	52
	MISSISSIPPIAN PLATEAU:	6	69	47	56	14
	OHIO RIVER ALLUVIUM:	2	4	0	0	4
NUMBER OF DETECTIONS ABOVE STANDARD	TOTAL:	39	6	0	290	235
	% DETECTIONS > STANDARD (of SAMPLES w/DETECTIONS):	36.4%	1.2%	0.0%	69.5%	72.3%
	% SAMPLES > STANDARD (of TOTAL SAMPLES):	7.0%	1.1%	0.0%	52.8%	55.2%
BY REGION:	BLUEGRASS (INNER & OUTER):	13	5	0	278	229
	EASTERN COAL FIELD:	26	0	0	12	5
	MISSISSIPPIAN PLATEAU:	0	1	0	0	1
	OHIO RIVER ALLUVIUM:	0	0	0	0	0
NUMBER OF SITES	TOTAL:	57	57	57	57	52
BY REGION:	BLUEGRASS (INNER & OUTER):	33	33	33	33	30
	EASTERN COAL FIELD:	19	19	19	19	18
	MISSISSIPPIAN PLATEAU:	4	4	4	4	3
	OHIO RIVER ALLUVIUM:	1	1	1	1	1
NUMBER OF SITES WITH DETECTIONS	TOTAL:	31	55	36	51	48
	% SITES W/DETECTIONS:	54.4%	96.5%	63.2%	89.5%	92.3%
BY REGION:	BLUEGRASS (INNER & OUTER):	15	33	22	31	29
	EASTERN COAL FIELD:	13	17	10	16	15
	MISSISSIPPIAN PLATEAU:	2	4	4	4	3
	OHIO RIVER ALLUVIUM:	1	1	1	0	1
NUMBER OF SITES WITH DETECTIONS ABOVE STANDARD	TOTAL:	17	4	0	39	31
	%SITES w/DETECTIONS>STANDARD (of SITES w/DETECTIONS):	54.8%	7.3%	0.0%	76.5%	64.6%
	%SITES w/DETECTIONS>STANDARD (of TOTAL SITES):	29.8%	7.0%	0.0%	68.4%	59.6%
BY REGION:	BLUEGRASS (INNER & OUTER):	7	3	0	30	27
	EASTERN COAL FIELD:	10	0	0	9	3
	MISSISSIPPIAN PLATEAU:	0	1	0	0	1
	OHIO RIVER ALLUVIUM:	0	0	0	0	0

	MCL (mg/L)	Secondary (mg/L)	Other
AMMONIA (NH_3-N)	0.110	-	-
NITRATE (NO_3-N)	10.000	-	-
NITRITE (NO_2-N)	1.000	-	-
ORTHO-PHOSPHATE (PO_4-P)	-	-	0.040
PHOSPHORUS, TOTAL	-	-	0.100

[1] Orthophosphate is not currently regulated, but Texas has a surface water quality standard for orthophosphate-P of 0.04 mg/L.

[2] Total Phosphorus is not currently regulated, but EPA water quality criteria state that phosphates should not exceed 0.100 mg/l in streams or flowing waters not discharging into lakes or reservoirs to control algal growth.

[3] Only 560 ammonia values out of 565 samples:
3 analyses: lab analyses for only pesticides and PCBs,
1 analysis: lab analysis for metals only,
1 analysis: ammonia not included in lab analysis.

[4] Only 559 nitrate values out of 565 samples:
3 analyses: lab analyses for only pesticides and PCBs,
1 analysis: lab analysis for metals only,
2 analyses: nitrate not included in lab analyses.

[5] Only 546 nitrite values out of 565 samples:
3 analyses: lab analyses for only pesticides and PCBs,
1 analysis: lab analysis for metals only,
5 analyses: nitrite not included in lab analyses,
10 analyses: analyses cancelled due to exceeded holding time.

[6] Only 549 orthophosphate values out of 565 samples:
3 analyses: lab analyses for only pesticides and PCBs,
1 analysis: lab analysis for metals only,
2 analyses: orthophosphate not included in lab analyses,
10 analyses: analyses cancelled due to exceeded holding time.

[7] Only 426 total phosphorus values out of 565 samples:
137 analyses: lab samples prior to October 1997 reported metals as dissolved, not total (52 out of 57 sites),
2 analyses: total phosphorus not included in lab analyses.

Table 18. Nutrients Descriptive Statistics

BMU1: NUTRIENTS DESCRIPTIVE STATISTICS						
	AMMONIA-N (NH_3-N) (mg/L)					
	START DATE	END DATE	MAX	MEDIAN	MIN	MODE
TOTAL:	**04/26/95**	**06/11/03**	**22.5**	**0.02**	**< 0.005**	**< 0.02**
BLUEGRASS (INNER & OUTER):	04/26/95	06/11/03	22.5	< 0.02	< 0.02	< 0.02
EASTERN COAL FIELD:	05/02/95	05/28/03	2.19	< 0.05	< 0.005	< 0.02
MISSISSIPPIAN PLATEAU:	04/27/95	06/11/03	< 0.09	< 0.02	< 0.02	< 0.02
OHIO RIVER ALLUVIUM:	04/21/99	03/07/00	0.08	0.052	< 0.05	< 0.05
	NITRATE-N (NO_3-N) (mg/L)					
	START DATE	END DATE	MAX	MEDIAN	MIN	MODE
TOTAL:	**04/26/95**	**06/11/03**	**18.28**	**1.55**	**< 0.004**	**0.02**
BLUEGRASS (INNER & OUTER):	04/26/95	06/11/03	18.28	3.05	< 0.004	< 0.004
EASTERN COAL FIELD:	05/02/95	05/28/03	9.33	0.18	< 0.004	< 0.007
MISSISSIPPIAN PLATEAU:	04/27/95	06/11/03	10.53	0.18	< 0.004	0.02
OHIO RIVER ALLUVIUM:	04/21/99	03/07/00	2.8	2.525	2.35	-
	NITRITE-N (NO_2-N) (mg/L)					
	START DATE	END DATE	MAX	MEDIAN	MIN	MODE
TOTAL:	**04/26/95**	**06/11/03**	**0.134**	**0.0045**	**0.0006**	**< 0.02**
BLUEGRASS (INNER & OUTER):	04/26/95	06/11/03	0.134	< 0.005	0.0006	< 0.02
EASTERN COAL FIELD:	05/02/95	05/28/03	0.031	< 0.005	< 0.001	< 0.02
MISSISSIPPIAN PLATEAU:	04/27/95	06/11/03	< 0.02	0.002	< 0.001	< 0.001
OHIO RIVER ALLUVIUM:	04/21/99	03/07/00	< 0.02	< 0.02	< 0.02	< 0.02
	ORTHOPHOSPHATE-P (PO_4-P) (mg/L)					
	START DATE	END DATE	MAX	MEDIAN	MIN	MODE
TOTAL:	**04/26/95**	**06/11/03**	**1.04**	**0.06**	**< 0.003**	**< 0.059**
BLUEGRASS (INNER & OUTER):	04/26/95	06/11/03	1.04	0.1805	< 0.003	< 0.059
EASTERN COAL FIELD:	05/02/95	05/28/03	0.197	< 0.019	< 0.003	< 0.059
MISSISSIPPIAN PLATEAU:	04/27/95	06/11/03	< 0.059	0.008	< 0.003	< 0.003
OHIO RIVER ALLUVIUM:	04/21/99	03/07/00	< 0.059	< 0.059	< 0.003	< 0.059
	TOTAL PHOSPHORUS (mg/L)					
	START DATE	END DATE	MAX	MEDIAN	MIN	MODE
TOTAL:	**07/16/97**	**06/11/03**	**0.938**	**0.1405**	**< 0.005**	**< 0.05**
BLUEGRASS (INNER & OUTER):	07/16/97	06/11/03	0.938	0.23	0.022	< 0.05
EASTERN COAL FIELD:	11/17/97	05/28/03	0.14	< 0.05	< 0.005	< 0.05
MISSISSIPPIAN PLATEAU:	12/02/97	06/11/03	0.12	< 0.05	< 0.005	< 0.05
OHIO RIVER ALLUVIUM:	04/21/99	03/07/00	0.055	0.032	0.018	-

Nitrate-N was analyzed in 559 samples and found in 512, or 91.6% (Table 17). Results ranged from non-detect to 18.28 mg/L, which occurred in the Bluegrass (Table 18). In BMU 1, row crops are common in the Bluegrass and the Mississippian Plateau and the occurrence of elevated nitrate-N, especially in the former, is evident in Figure 46. The median value for BMU 1 was 1.55 mg/L, and values were elevated in agricultural and residential areas compared to reference sites and those in forested areas (Figure 47). Four sites (Figure 48) had detections above the MCL.

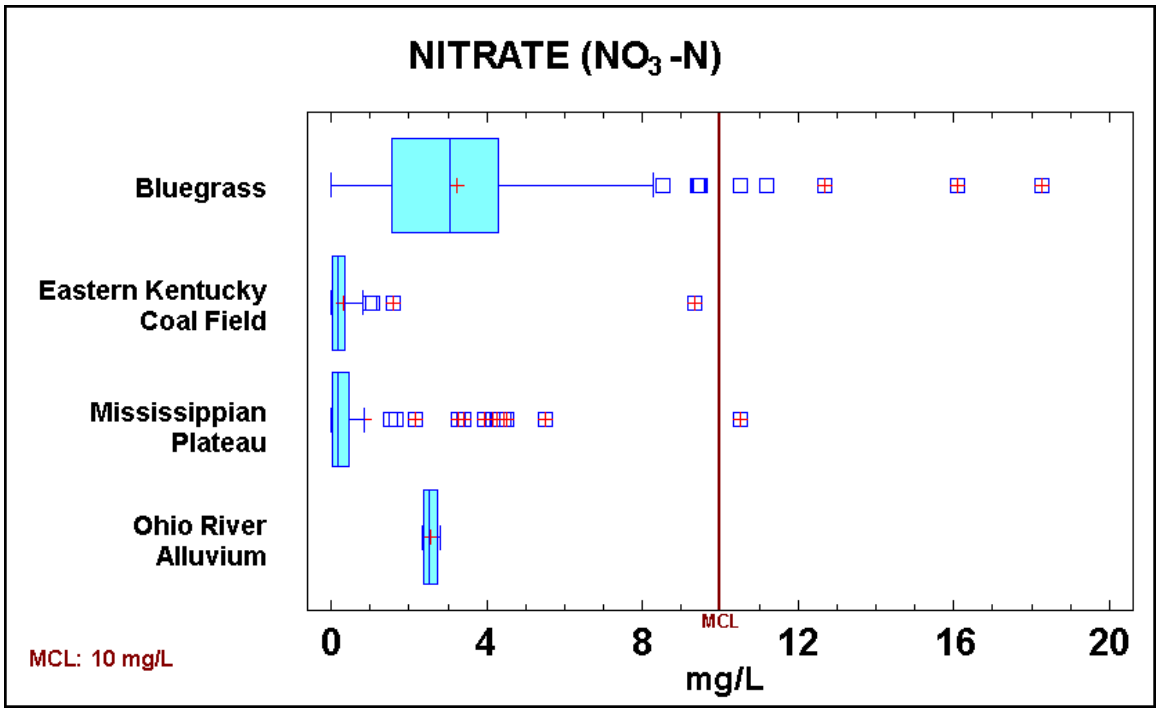

Figure 46. Boxplot of Nitrate-N and Physiographic Regions

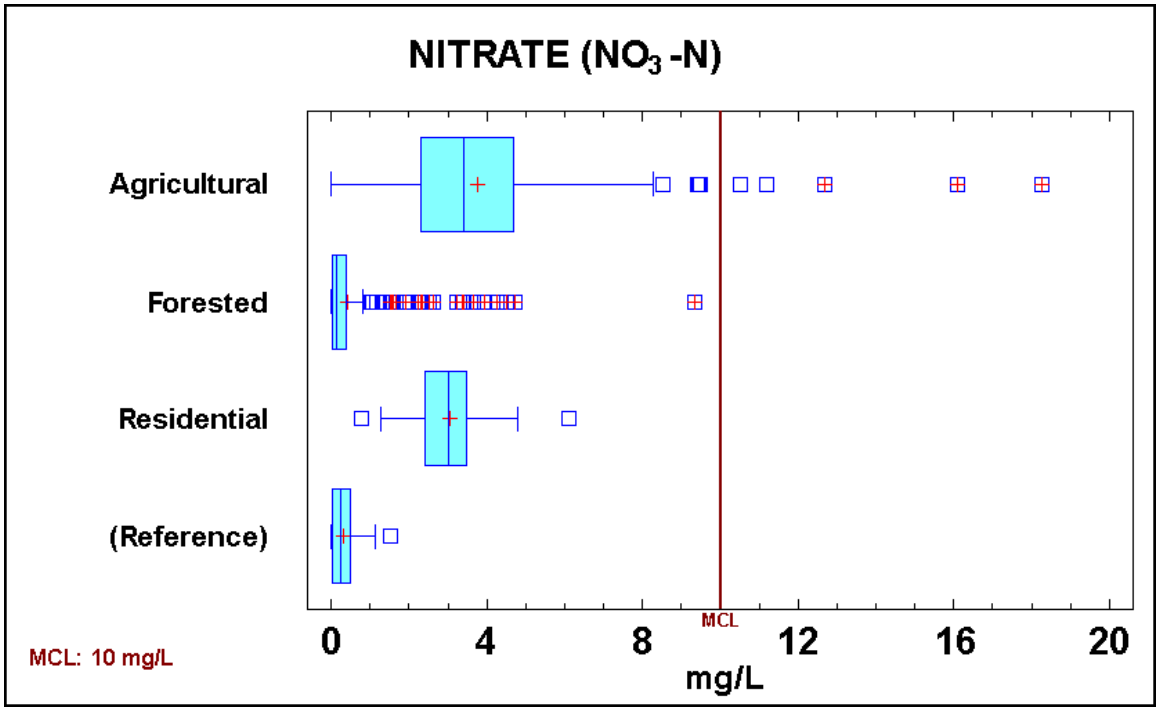

Figure 47. Boxplot of Nitrate-N and Land Use